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APPENDIX A – GLOSSARY

Aboriginal: Native, indigenous.

Active Crown Fire: When the main surface fire and the fire burning in the crowns are moving together across the fire front.

Adaptive Management: A type of natural resource management that implies making decisions as part of an on-going process. Monitoring the results of actions will provide a flow of information that may indicate the need to change a course of action. Scientific findings and the needs of society may also indicate the need to adapt resource management to new information.

Appropriate Management Response: The response to a wildland fire is based on an evaluation of risks to firefighter and public safety, the circumstances under which the fire occurs, including weather and fuel conditions, natural and cultural resource management objectives, protection priorities, and values at risk. The evaluation must also include an analysis of the context of the specific fire within the overall local, geographic area, or national wildland fire situation.

Arthropod: A group of invertebrates which have a segmented body and jointed limbs and an external skeleton (e.g. insects, spiders and crustaceans).

Artifact: An object that was made, used, and/or transported by humans that provides information about human behavior in the past.

Aspect: The direction a slope faces. For example, a hillside facing east has an eastern aspect.

Backcountry: Areas of the monument generally without modern developments, such as roads and utilities.

Backing fire: Fire spreading, or ignited to spread, into (against) the wind or downslope. A fire spreading on level ground in the absence of wind is a backing fire.

Biological Diversity (Biodiversity): The number and abundance of species found within a common environment. This includes the variety of genes, species, ecosystems, and the ecological processes that connect everything in a common environment.

Biomass: 1. Wood products that may or may not be used commercially
2. The total weight of all living organisms in a biological community.

Biota: The plant and animal life of a particular region.

Broadcast Burning: Intentional burning within well defined boundaries for reduction of fuel hazard, as a resource management treatment, or both.

Burned Area Rehabilitation: The full range of post-fire activities to rehabilitate and restore fire damaged lands, including protection of public health and safety.

Caldera: A vast depression at the top of a *volcanic cone*, formed when an eruption substantially empties the reservoir of *magma* beneath the cone's summit. Eventually the summit collapses inward, creating a caldera.

Canopy: The part of any stand of trees represented by the tree crowns. It usually refers to the uppermost layer of foliage, but it can be used to describe lower layers in a multi-storied forest.

Catastrophic Fire: See stand replacing fire.

Carrion: The decaying flesh of a dead animal that is used as food for scavenging animals.

Cavate: A cavity in the canyon wall that is primarily the result of excavation of the rock.

Collaboration: Managers, scientists and citizens working together to plan, implement and monitor land management activities. The intention is to engage people who have information, knowledge, expertise and an interest in the health of natural ecosystems and nearby communities.

Control Burn: See Prescribed Fire or Burn.

Cooperators: Federal, state, and local agencies and Indian tribes that participate in planning and conducting fire management projects and activities.

Critical Habitat: Areas designated for the survival and recovery of state or federally listed threatened or endangered species.

Crypto-crystalline: An adjective applied to materials, particularly rocks and minerals, whose texture is so fine that no distinct particles are visible, even under the microscope.

Cultural Resource: Includes historic properties such as archeological sites, traditional cultural properties, cultural landscapes, historic structures, as well as specific cultural values.

Cultural Landscape: The spatial distribution of cultural activities across a landscape at a given moment in time.

Degradation: Reduction in quality.
1. The process whereby the water quality and chemical, physical or biological integrity of a water body is decreased.
2. Habitat quality can be changed by certain management activities. If the quality is reduced then habitat degradation has occurred.

Dendroglyph: Pictures, symbols, or other artwork pecked, carved or incised on living trees.

Diurnal: Having a daily cycle or occurring every day.

Diversity: The distribution and abundance of different plants and animals within an area.

Ductility: The ability of a material to be stretched into a new shape without it breaking.

Duff: The partially decomposed organic material of the forest floor that lies beneath the freshly fallen twigs, needles and leaves. The fermentation and humus layers of the forest floor.

Ecosystem: An arrangement of living and non-living things and the forces that move them. Living things include plants and animals. Non-living parts of ecosystems may be rocks and minerals. Weather and wildland fire are two of the forces that act within ecosystems.

Ecosystem Sustainability: The capacity to maintain ecosystem health, productivity, diversity, and overall integrity, in the long run, in the context of human activity and use.

Edge Effects: Habitat conditions created at or near the more-or-less well-defined boundary between ecosystems, as, for example, between open areas and adjacent forest.

Efflorescence: The accumulation of minerals on an exposed surface often due to moisture migrating through a masonry wall, evaporating, and leaving the dissolved minerals in the moisture on the exposed surface.

Emission: The release or discharge of a substance into the environment; generally refers to the release of gases or particulates into the air.

Endangered Species: Those plant or animal species that are in danger of extinction throughout all or a significant portion of their range. Endangered species are identified by the Secretary of the Interior in accordance with the Endangered Species Act of 1973.

Episodic: Occurring or appearing at usually irregular intervals.

Erosion: The wearing away of land or soil by the action of wind, water, or ice.

Escarpment: A long, more or less continuous cliff or relatively steep slope produced by erosion or by faulting.

Ethnographic Resources: Resources that relate to the aspect of cultural anthropology concerned with the descriptive documentation of living cultures.

Fauna: The animal life of an area.

Fine Fuels: Fuels that ignite readily and are consumed rapidly by fire (e.g., cured grass, fallen leaves, needles, small twigs less than ¼ inch diameter, also referred to as 1-hour fuels).

Fire Frequency: A general term referring to the recurrence of fire in a given area over time.

Fire Hazard: A fuel complex, defined by volume, type, condition, arrangement, and location, that determines the degree of ignition and of resistance to control. For example, the moisture content of the fuel will influence the ability of the fuel to catch and sustain fire (degree of ignition) and how difficult it will be to control or extinguish the fire (degree of control).

Fire Management Activities: Include fire planning, fire management strategies, tactics, and alternatives, prevention; preparedness, education, and addresses the role of mitigation, post-fire rehabilitation, fuels reduction, and restoration activities in fire management.

Fire Management Plan: A strategic plan that defines a program to manage wildland fires based on an area's approved land management plan. Fire Management Plans must address a full range of fire management activities that support ecosystem sustainability, values to be protected, protection of firefighter and public safety, public health and environmental issues, and must be consistent with resource management objectives and activities of the area.

Fire Management Units: Geographic areas based upon similar values such as desired landscape conditions, strategies to manage fires, post-fire restoration strategies, fuels management strategies and other management values such as wildland urban interface, natural or cultural resources.

Fire Regime: The combination of fire frequency, predictability, intensity, severity, seasonality, and extent that is characteristic of fire in a particular ecosystem.

Fire Return Interval: Describes the average range of years between naturally occurring fire events in different vegetation types. Expressed as the arithmetic average (mean fire return interval) of all fire intervals in a given area over a given time period.

Fire Return Interval Departure: The number of fire return intervals that would have occurred naturally in the absence of fire suppression.

Fire Risk: See wildland fire risk.

Flora: The plant life of an area.

Floristic Elements: Different species present in the flora.

Foraging: The act of searching for food and provisions.

Friability: Excessive breakableness.

Frontcountry: Areas of the monument that include modern developments, such as roads and utilities.

Fuel Hazard: A fuel complex defined by kind, arrangement, volume, condition, and location that forms a special threat of ignition and resistance to control.

Fuelbreak: A system of linear or mosaic patch treatments of forest or shrub vegetation designed and treated to reduce fire spread, intensity, and create barriers to fire spread.

Fuel load: The amount of combustible material (dead plants and trees, litter, and duff) that is found in an area.

Fuels: Plants and woody vegetation, both living and dead, that are capable of burning.

Fuels Management: The planned manipulation and/or reduction of living and dead forest fuels for forest management and other land use objectives.

Fuels Treatment: The treatment of fuels that left untreated, would otherwise interfere with effective fire management or control. For example, prescribed fire can reduce the amount of fuels that accumulate on the forest floor.

Germination: The beginning of vegetative growth of a plant from a seed.

Habitat: The area where a plant or animal lives and grows under natural conditions.

Handline: A line cleared of all vegetation and fuels (down to mineral soil) used to help control a fires spread. Width varies depending on fuel type.

Hazard Reduction: In fuels management: the planned treatment or manipulation of naturally growing vegetation or any other flammable material for the purpose of reducing the rate of spread and the output of heat energy from any wildland fire occurring in the treated area.

Hazard Reduction Prescription: These are the specific parameters used to describe the conditions such as specific width, patch size and shape, species composition, diameter distributions, canopy cover, surface fuel mosaic, fire behavior, and location. They are determined at the site-specific project level based on topography, access, vegetation, risk of ignition, and potential fire behavior (this includes weather and wind).

Helispots: Areas cleared of vegetation and dead and down fuels used to land helicopters.

Herbaceous: Referring to a plant that has little or no woody tissue and usually persists only for a single growing season.

Hibernacula: The places in which an animal hibernates or overwinters.

Holding line: A natural or human-made line that is used to limit the spread of a fire. A holding line can either be a line clear of burnable fuels, or a line that is pretreated by water or retardant to be made fire resistant.

Hydrophobicity: Or water repelancy can develop in soils as a result of drying or fire.

Igneous rock: Rock formed by the cooling and hardening of molten materials: granite, basalt, lava.

Infiltration: Flow of water from the land surface into the subsurface.

Initial Attack: The aggressive response to a wildland fire based on values to be protected, benefits of response, and reasonable cost of response.

Interdisciplinary Team: A diverse group of professional resource specialists who analyze the effects of Alternatives on natural and other resources. Through interaction, participants bring different points of view and a broader range of expertise.

Interagency Coordination: Collaboration, communication among cooperating agencies.

Intermittent Stream: A stream that flows only at certain times of the year when it receives water from streams or from some surface, such as melting snow.

Ladder Fuels: Fuels, such as branches, shrubs or an understory layer of trees, which allow a fire to spread from the ground to the canopy.

Landscape: A large land area composed of interacting ecosystems that are repeated due to factors such as geology, soils, climate, and human impacts.

Limbing: Removal of large tree limbs to reduce fuel load and the potential for crown fires.

Lithic: Of or pertaining to stone. In archaeology, lithic artifacts include ground and chipped stone tools and the debris resulting from their manufacture.

Long-term Risk: A risk to be experienced within the next 50 to 100 years.

Lopped: Plants or trees having the top or outer parts cut off.

Management Action: Any activity undertaken as part of the administration of the national park.

Manual Thinning: A method used to trim limbs from trees as well as cut down individual trees and other vegetation using a chainsaw, crosscut saw, or axe.

Mechanical Thinning: A method used to cut down trees and other vegetation using vehicles, equipment, and other specialized apparatus.

Mesic: Characterized by intermediate moisture conditions, neither decidedly wet nor decidedly dry. The mid-range of the moisture scale from wet to dry.

Metamorphic Rock: Rock that forms when sedimentary, igneous, or other metamorphic rock is heated and/or squeezed. Most metamorphic rocks form deep inside the Earth where heat and pressure are intense enough to change the shape of mineral crystals and even change one group of minerals into another.

Microbial Communities: Soil organisms capable of deriving carbon for growth and cell synthesis from organic compounds; includes bacteria, actinomycetes, fungi, and algae.

Mineral Soil: The portion of the soil profile immediately below the litter and duff layers. This portion contains very little combustible material except where an upper soil horizon may be enriched with organic matter.

Mop Up: Action that entails securing or cleaning up the fire after fireline is established (could be internal or around the perimeter).

Mosaic: Areas with a variety of plant communities over a landscape. For example, areas with trees and areas without trees occurring over a landscape.

Mutual Aid: A system wherein two or more fire departments, by prior agreement, operate essentially as a single agency to respond routinely across jurisdictional boundaries to render mutual assistance in combating fire emergencies.

Mycorrhizal: Refers to a mutually beneficial association between a fungus and the roots of a plant.

Native (Species): Any species of plant or animals native to a given land or water area by natural occurrence.

Natural Succession: The natural replacement, in time, of one plant community with another. Conditions of the prior plant community (or successional stage) create conditions that are favorable for the establishment of the next stage.

Noxious Weeds: Aggressive, non-native plant species that have been introduced. They can be difficult to manage, poisonous, toxic, parasitic, or carrier of insects or disease.

Nutrient Loading: The nutrient ***load*** refers to the total amount of nitrogen or phosphorus entering water during a given time, such as "tons of nitrogen per year." Nutrient ***loading*** is a large quantity of these nutreints that may enter the water from runoff, groundwater, or the air.

Nutrient Cycling: The passage of nutrients through an ecosystem so that they eventually become available once again to the primary producers.

Operational Plan: A written plan of action for a specific project or incident. Examples of operational plans could include burn plans, incident action plans, or non-fire treatment plans.

Overstory: Overstory is the larger, taller trees of growth which occupies a forest area and shades young trees, hardwoods, brush, and other deciduous varieties which are growing beneath the larger trees (i.e., understory).

PM 10 and 2.5: These are Particles found in the air. They can come in almost any shape or size, and can be solid particles or liquid droplets. One of the differences is size, we call the bigger particles PM10 and we call the smaller particles PM2.5.

Passive Crown Fire: An intense surface fire that torches occasional individual trees or small groups of trees, during this condition the surface fire is moving faster than the occasional torching of trees. Any spotting is usually short range less than ¼ mile and supports the surface fire spread.

Perennial: A plant which continues to grow after it has reproduced, usually meaning that it lives for several years.

Petroglyph: Pictures, symbols, or other artwork pecked, carved or incised on natural rock surfaces

Pictograph: A type of rock art in which a design is painted onto stone.

Pile Burning: Controlled burning of slash (trees, brush, branches) removed during thinning.
Porosity: The degree to which the total volume of soil, gravel, sediment, or rock is permeated with pores or cavities through which fluids (including air) can move.

Prescribed Fire or Burn: Any fire ignited by management actions to meet specific objectives. Prescribed fires are conducted in accordance with prescribed fire plans.

Prescribed Fire Plan: A plan for each prescribed fire. Plans are documents prepared by qualified personnel, approved by the agency administrator, and include criteria for the conditions under which the fire will be conducted (a prescription).

Prescription: Measurable criteria that define the conditions under which a prescribed fire will be ignited, guide selection of appropriate management responses, and indicate other required actions. Prescription criteria may include safety, economic, public health, and environmental, geographic, administrative, social, or legal considerations.

Projects (or project areas):From the National Fire Plan Operations and Reporting System (NFPORS) A collection of Treatments and Activities. A Project is defined by the user but is generally considered to be the area of planning. All the Treatments in a Project are approved and conducted under a single NEPA decision document. A Project is persistent – it is not limited to any time period. A Project has a Centroid, a Name, and may be associated with the HFRA.

Propagules: The shoot, seed or other method that plants use to spread or propagate (reproduce).

Riparian Area: The area along a watercourse or around a lake or pond.

Roost: A place to rest or sleep.

Section 7: The section of the Endangered Species Act that requires all Federal agencies, in "consultation" with the Service, to insure that their actions are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat**.**

Section 106 consultation: Refers to **§106** of the National Historic Preservation Act, which requires federal agencies to take into account the effects of their proposed undertakings on properties included or eligible for inclusion in the National Register of Historic Places and give State Historic Preservation Officers/Tribal Historic Preservation Officers and, as necessary, the Advisory Council on Historic Preservation a reasonable opportunity to comment on the proposed undertakings.

Sedimentation: The accumulation of geological or organic material deposited by air, water, or ice.

Sensitive Species: Plant or animal species which are susceptible to habitat changes or impacts from activities.

Seral stage: Any stage of development of an ecosystem from a disturbed, un-vegetated state to a climax plant community.

Short-term Risk: A risk to be experienced within the next 10 to 15 years. For example, prescribed burns can disturb habitat in the short-term, but in the long-term the fire resiliency of the habitat may be improved.

Slash: Debris left as a result of forest and other vegetation being altered by forestry practices and other land use activities (e.g., timber harvesting, thinning and pruning, road construction, seismic line clearing).

Slash includes material such as logs, splinters or chips, tree branches and tops, and uprooted stumps, trees and shrubs.

Snag: A standing dead tree. Snags are important as habitat for a variety of wildlife species and their prey.

Snagging: The act of cutting down standing dead trees which could fall over a fireline, or which are in an area where firefighters are working below.

Soil horizons: A layer of soil which can be distinguished from adjacent layers by characteristic physical properties such as texture, structure, or color, or by chemical composition.

Special Status Species: Species federally listed as threatened or endangered under the Endangered Species Act of 1973, as amended (ESA); species that are proposed or are candidates for listing under ESA or federal species of concern that are not protected pursuant to ESA but are monitored for conservation status; and State of New Mexico listed threatened or endangered species and special status plant species.

Species: A class of individuals having common attributes and designated by a common name; a category of biological classification ranking immediately below the genus or subgenus; comprising related organisms or populations potentially capable of interbreeding.

Spike Camps: A camp is a geographical site(s), within the general incident area, separate from the incident base, equipped and staffed to provide sleeping, food, water, and sanitary services to incident personnel. Spike camps are generally small and highly temporary. These occur mostly in areas inaccessible by road and are frequently supplied by helicopter or pack-train.

Stand: A group of trees that occupies a specific area and is similar in species, age, and condition.

Stand-Replacing Fire: A fire that burns with sufficient intensity to kill the majority of living vegetation over a given area (grass and brush fires are stand replacement fires for that vegetation type, in forest vegetation types when 75- 80% of the stand is killed by fire are also considered stand replacement fires).

Surface fuels: All materials lying on or immediately above the ground including needles or leaves, duff, grass, small dead wood, downed logs, stumps, large limbs, low brush, and reproduction.

Synergistic: The action of two or more substances (or things) to produce an effect that neither alone could accomplish.

Taxa: Any grouping within the classification of organisms, such as species, genus, and order.

Tensile Strength: The ability of a structural material to withstand bending and stretching forces.

Threatened Species: Those plant or animal species likely to become endangered throughout all or a specific portion of their range within the foreseeable future as designated by the U.S. Fish and Wildlife Service under the Endangered Species Act of 1973.

Tractability: The trait of being easily persuaded.

Treatments: From the National Fire Plan Operations and Reporting System (NFPORS): The work activity that takes place on the Treatment Unit and is directly aimed at accomplishing goals of the National Fire Plan BARR or HFR. A Treatment is planned and conducted in one Fiscal Year.

Treatment Units: From the National Fire Plan Operations and Reporting System (NFPORS):
The tract of land where a *unique set* of Treatments is conducted. In the Hazardous Fuels Reduction module, Treatment Units are always 2-dimensional (Unit of Measure is acres). A Treatment Unit is persistent and

has a Centroid_(location). This means that once created, a Treatment Unit is permanently kept in the database.

Tuff: A rock composed of the finer kinds of volcanic detritus, usually fused together by heat.

Turbidity: A measure of water cloudiness caused by suspended solids.

Understory: The trees and woody shrubs growing beneath branches and foliage formed collectively by the upper portions of adjacent trees.

Values at Risk: A total assessment of resources, such as property, structures, natural and cultural resources, and economic, political, environmental, and social values, which may be affected by an incident now and in the foreseeable future.

Vegetation successional pathways: The process by which a series of different plant communities (and associated animals and microbes) successively occupy and replace each other over time in a particular ecosystem or landscape following a disturbance to that ecosystem. Includes the accompanying change in the nonliving environment (soil and microclimate).

Vesiculation: A process in which the volatiles dissolved in a glass such as obsidian are released, creating bubbles in the glass.

Viewshed: Everything visible from a particular vantage point.

Water Bars: A diagonal ditch or hump in a trail that diverts surface water runoff to minimize soil erosion.

Watershed: The entire region drained by a waterway, lake, or reservoir. More specifically, a watershed is an area of land above a given point on a stream that contributes water to the streamflow at that point.

Wilderness: Wilderness is a congressionally mandated area withdrawn from location and entry under the US mining laws.

Wildland Fire: Any non-structural fire that occurs on wildlands that is not a prescribed fire.

Wildland Fire Implementation Plan (WFIP): A progressively developed assessment and operational management plan that documents the analysis and selection of strategies and describes the appropriate management response for a wildland fire being managed for resource benefits. A full WFIP consists of three stages. Different levels of completion may occur for differing management strategies (i.e., fires managed for resource benefits will have two-three stages of the WFIP completed while some fires that receive a suppression response may only have a portion of Stage I completed).

Wildland Fire Use for a Resource Benefit: A natural (lightning) ignited fire that is managed to meet resource benefits.

Wildland Urban Interface: A line, area, or zone where structures and other human development meet or intermingle with undeveloped land or naturally occurring flammable fuels.

Wildlife Corridors: A strip or block of habitat connecting otherwise isolated units of suitable habitats that allow the dispersal of organisms and the consequent mixing of genes. A corridor is also beneficial to plant populations that have been isolated due to fragmentation.

APPENDIX B
ACRONYMS AND ABBREVIATIONS

A.D.	Anno Domini; in the year of the Lord (Latin); since the birth of Jesus Christ (used in designating dates)
APE	Area of Potential Effect
approx.	approximately
B.C.	Before Christ (used in designating dates).
BA	Biological Assessment
BO	Biological Opinion
BW	Backcountry/Wilderness
C	Celsius
CCC	Civilian Conservation Corps
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CG	Cerro Grande
CLI	Cultural Landscape Inventory
CO	Carbon Monoxide
DBH	Diameter at Breast Height
DFC	Desired Future Conditions
DO	Director's Order (refers to National Park Service Director)
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
est.	estimate
FMP	Fire Management Plan
FRCC	Fire Regime Condition Class
ft.	feet
HQ	Headquarters
IDT	Inter-Disciplinary Team
LCES	Lookouts, Communications, Escape Routes and Safety Zones
LCS	List of Classified Structures
LF	Lower Frijoles
mi/hr	miles per hour
MIST	Minimum Impact Suppression Tactics
MMA	Maximum Manageable Area
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MTA	Minimum Tool Analysis
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Protection Act
NHPA	National Historic Preservation Act
NMAC	New Mexico Administrative Code
NMDGF	New Mexico Department of Game and Fish
NO2	Nitrogen dioxide
NOX	Nitrogen Oxide
NPS	National Park Service
NRZ	Nesting/Roosting Zone
O3	Ozone
Pb	Lead
PM10	Particulate Matter with a diameter of 10 micrometers or less
PM2.5	Particulate matter with a diameter of 2.5 micrometers or less

PPb	Parts per billion
PPE	Personal Protective Equipment
PSD	Prevention of Significant Deterioration
RM-18	National Park Service Reference Manual-18: Wildland Fire Management
SHPO	State Historic Preservation Office
SNA	suitable nesting area
SO2	Sulfur dioxide
TCP	Traditional Cultural Properties
U.S.	United States

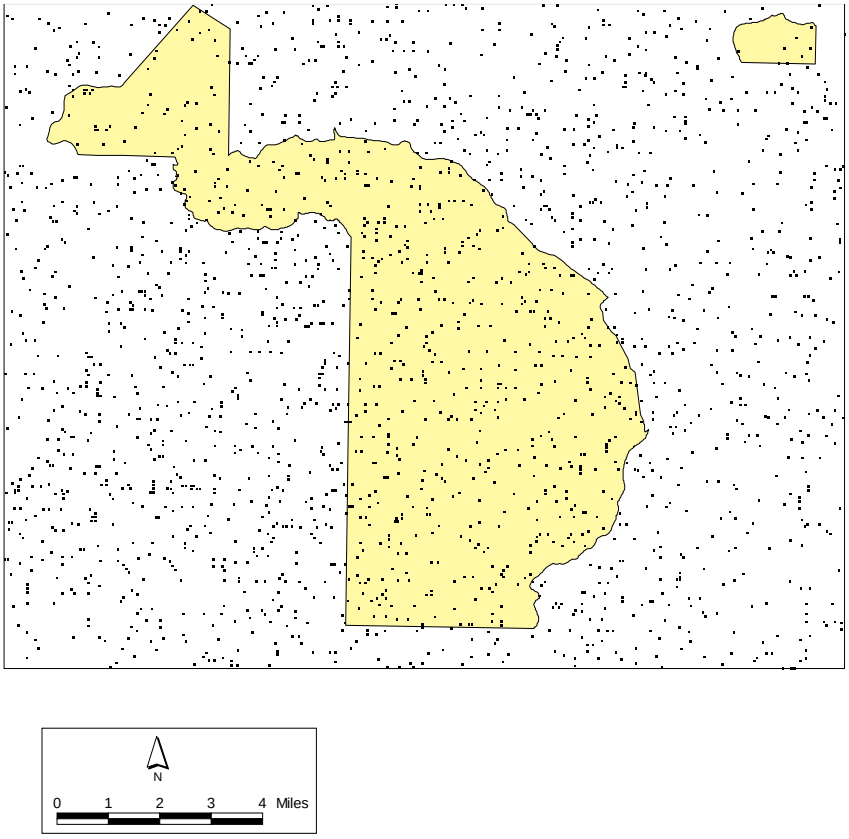
APPENDIX C

FIRE HISTORY/ECOLOGY OF BANDELIER AND THE JEMEZ MOUNTAINS

Fire is considered a keystone natural process in maintaining the structural and functional integrity of Bandelier's vegetation communities. This concept is supported by numerous data sources, such as historic records and journals, aerial and ground-based photos, charcoal deposits from bogs, dendrochronological reconstructions of fire occurrence patterns and precipitation, and field sampling of soils and vegetation (Allen, 1995) (Allen, 2002). These extensive historic fire studies have produced detailed descriptions of the spatial and temporal variability in fire frequency, intensity, and extent in Bandelier and the Jemez Mountains. For example, fire scar samples from several different ponderosa pine sites in the Jemez Mountains recorded approximately 1,858 fire events and 221 different fire years over a 400-year period (between 1480 and 1899). The mean fire return interval (the average number of years between fire events) recorded for these sites was 5-16 years (Touchan and Swetnam, 1995). In another study, conducted in the ponderosa pine forests within Bandelier, fire scar samples showed 113 separate fire years between 1480 and 1899 with fires averaging every 5-15 years (Allen, et. al. 1995).

The frequent and widespread fire activity in Bandelier and the Jemez Mountains is primarily due to the high occurrence of lightning strikes. The southwest has the highest rate of lightning ignited fires in the United States (Swetnam and Baisan, 1996). 165,117 cloud-to-ground lightning strikes were recorded in a 775,554 ha area in the Jemez Mountains between the years of 1985-1994 (Figure C.1). An average of sixty-two thunderstorm days per year are recorded in the area, producing between 9,410 and 23,317 lightning strikes annually (Allen, 2002). Accordingly, 86% of the historic fires recorded in Bandelier were the result of lightning strikes (Allen, 1984).

Figure C.1 Lightning Strikes from 1985-1994 in Bandelier National Monument



Lightning ignited fires occur most frequently in the warm and dry months of May and June, before the onset of the summer monsoonal rains. During these months, lightning strikes occur from clouds that release only virga (rain that evaporates before reaching the Earth's surface), offering an ignition source to dry fuels (Allen, 2002). Lightning strikes actually occur more during the monsoonal period (July-September) than in May and June. However, ignitions are less frequent because 40% of the area's annual precipitation (approximately 12-35 inches, depending on elevation) is released during these storms and fuel moistures are generally higher. The El Nino-Southern Oscillation atmospheric phenomenon has comparable significant effects on fuels, resulting in increased fire occurrence and intensity. During the wet El Nino years the fine fuel production is

increased and then becomes available for fire ignition and spread in the following dry La Nina year (Touchan and Swetnam, 1995).

Apparently the above mentioned climatic conditions and resulting fire and vegetation patterns developed 8,000-11,000 years ago. Charcoal sediments from a bog in the Jemez Mountains provide evidence of persistent fire activity dating back at least 9,000 years (Allen, 2002).

Topographic features, such as slope aspect and steepness of slope, are also factors that contribute to the historic widespread fire activity in Bandelier. Research shows that slope aspect can significantly affect the occurrence of fire ignitions. Median fire return intervals on south facing slopes have been found to be shorter than on north facing slopes (Beaty and Taylor, 2001), suggesting that fires generally occur more frequently in areas with a southerly exposure, where fuels tend to be drier. The steepness of a slope can affect the rate of fire spread and the extent of fires. Fire moving up a steep hill can dry the fuels ahead of its flaming front, allowing for faster fuel consumption and fire spread.

In summary, many factors, including a high concentration of lightning strikes, climatic conditions, and topography, make fire one of the dominant natural disturbance processes at Bandelier. Consequently, most of the vegetation communities and wildlife that have persisted through time are now fire-dependent.

Long-term Effects of Fire Suppression on Bandelier's Natural and Cultural Resources/Alteration of Bandelier's Fire Regimes

Fire regime is a term used to describe attributes, such as the frequency, intensity, extent, and duration, of a naturally occurring fire as it would typically burn in a particular vegetation community or landscape. One aspect of the fire regime that is of particular interest is fire frequency, which can vary greatly depending on the vegetation community. The frequency of naturally occurring fire in a specific vegetation community is typically expressed as an average range, called the *fire return interval*. For example, fires historically occurred an average of every 5-15 years in Bandelier's ponderosa pine forests (Allen et al., 1995). When these naturally occurring fires are regularly suppressed, the *fire return interval*, and therefore the natural *fire regime*, is disrupted. One way of describing or quantifying this disruption is by the *fire return interval departure,* defined as the number of *fire return intervals* that would have occurred naturally if fires had not been suppressed. A high departure from the natural fire regime indicates that the ecological integrity of the vegetation community or landscape may be compromised. This is the case at Bandelier National Monument.

Research shows that fire was a dominant natural force throughout the Jemez Mountains until the 1880's, when a variety of landuse practices such as extensive grazing and timber extraction began. After the cessation of grazing, fire would have continued to occur throughout the Jemez Mountains, but aggressive fire suppression efforts began in the early 1900's. The proliferation of these landuse practices resulted in near cessation of

fires and, over time, has produced significant ecological effects on Bandelier's fire prone-landscapes. Today, after more than 100 years of active fire suppression, Bandelier's ecosystems are experiencing high accumulations of litter, duff, and dead and down woody fuels, increased tree densities, low herbaceous cover, decreased availability of soil nutrients, decreased plant productivity, increases in disease, insect infestations, and mortality in trees, loss of habitat, and increases in large stand replacing fires. Conflagrations like the 1977 La Mesa Fire, the 1996 Dome Fire, and the 2000 Cerro Grande Fire are becoming more frequent in ponderosa pine forests, where stand replacing fire events were once anomalous. In addition, subtle but important hydrological changes may be occurring because of increased forest growth. Decreased runoff and infiltration may be altering the water table around meadows, helping to accelerate tree invasions. The combination of high tree densities and increased forest fuels also increases the potential for insect and pathogen infestations, which may cause tree die-off and further increase the potential for fire. In the event of catastrophic fire, entire forest landscapes can be denuded and reverted to shrub communities, watershed and soil processes can be compromised, and other ecosystem values can be greatly altered.

Fire suppression has also affected many wildlife species by causing deterioration of their preferred habitats, and in some cases, by altering habitat that is critical for the survival of certain species. For example, the cover of many key herbaceous species is reduced in the absence of periodic fire and the wildlife that depend on these plants have less available forage. Other species, such as woodpeckers, that depend on fire-created snags for food (insects) and shelter may suffer a decline in the absence of fire. These effects can also extend up the food chain. For example, meadows and other grassy areas that are maintained by periodic fire support rodent populations that are the prey base for many carnivorous species, such as owls. In the absence of fire, these rodent populations tend to decline, most likely causing a reduction in carnivorous populations.

An example of a departure from the natural fire regime of ponderosa pine follows:

Historically:

Fire history studies conducted at Bandelier indicate that before the 1880's frequent low intensity surface fires in ponderosa pine forests played a major role in maintaining species compositions and forest structures (Allen et al., 1995). The forests contained a full range of age classes, from seedlings, to mid-story trees, and overstory trees. Abundant grasses and forbs existed in the understory. Horizontal and vertical forest fuels were periodically consumed and maintained at low levels (5-12 tons/acre), avoiding damage to soils and canopy root systems. Understory tree density was low, limiting the spread of fire into tree canopies, and therefore reducing the frequency of stand replacing fire events (Allen, 1989). Additional studies show that the approximate average size of these low intensity fires was 3,000 acres (Covington and More, 1992). (See Figure C.2 below of what a historic ponderosa pine forest in Bandelier may have looked like).

Figure C.2 An example of the possible structure of a historic ponderosa pine forest in Bandelier.

Current situation:

An assessment of forest structure at Bandelier shows that the absence of frequent, low intensity fire has altered and degraded Bandelier's ponderosa pine forests in many ways. The full range of age classes that existed historically has been replaced by extremely high densities of seedling trees (approximately 350 trees/acre) and mid-story trees (200 trees/acre). Herbaceous plant cover and productivity has decreased, as up-slope recruitment of pinyon and juniper trees and downslope recruitment of mixed conifer trees is observed. The fuel loading is recorded at approximately 33 tons/acre, much higher than the estimated 5-12 tons/acre for historic conditions (NPS, unpublished data). It is clear that these current forest conditions, most notably the high accumulations of fuels and increased tree densities, have created the opportunity for the high intensity, high severity, stand replacing and stand destroying fires that are occurring today. The increased tree densities provide ladder fuels allowing fire into the tree canopies and the compacted litter and duff can cause a much longer fire residence time, increasing fire severity and possibly resulting in deleterious effects on soil properties as well as on the shallow rooted mature ponderosa pines. The approximate size of recent fires in ponderosa pine are: La

Mesa Fire of 1977: 14,250 acres; Dome Fire of 1996: 16,500 acres; and the Cerro Grande Fire of 2000: 43,000 acres. (See Figure C.3 below for a photo of a current ponderosa pine forest in Bandelier.

Figure C.3 The current structure of a ponderosa pine forest in Bandelier.

APPENDIX D

MINIMUM IMPACT SUPPRESSION TACTICS

NWCG Guidance on Minimum Impact Suppression Tactics
In Response To the

10-YEAR IMPLEMENTATION PLAN FOR REDUCING WILDLAND FIRE RISKS TO COMMUNITIES AND THE ENVIRONMENT

POLICY

The change from **fire control** to **fire management** has added a new perspective to the role of fire manager and the firefighter. Traditional thinking that "the only safe fire is a fire without a trace of smoke" is no longer valid. Fire Management now means managing fire "with time" as opposed to "against time." The objective of putting the fire dead out by a certain time has been replaced by the need to make unique decisions with each fire start to consider the land, resource and incident objectives, and to decide the appropriate management response and tactics which result in minimum costs and minimum resource damage.

This change in thinking and way of doing business involves not just firefighters. It involves all levels of management. Fire management requires the fire manager and firefighter to select management tactics commensurate with the fire's potential or existing behavior while producing the least possible impact on the resource being protected. The term used to describe these tactics is "Minimum Impact Suppression Tactics", commonly called MIST. Simply put: MIST is a 'do least damage' philosophy.

MIST is not intended to represent a separate or distinct classification of firefighting tactics but rather a mind set - how to suppress a wildfire while minimizing the long-term effects of the suppression action. MIST is the concept of using the minimum tool to safely and effectively accomplish the task. MIST should be considered for application on all fires in all types of land management.

While MIST emphasizes suppressing wildland fire with the least impact to the land, actual fire conditions and good judgment will dictate the actions taken. Consider what is necessary to halt fire spread and containment within the fireline or designated perimeter boundary, while safely managing the incident.

Use of MIST **will not** compromise firefighter safety or the effectiveness of suppression efforts. Safety zones and escape routes will be a factor in determining fireline location

Accomplishments of minimum impact fire management techniques originate with instructions that are understandable, stated in measurable terms, and communicated both verbally and in writing. They are ensured by monitoring results on the ground.

Evaluation of these tactics both during and after implementation will further the understanding and achievement of good land stewardship ethics during fire management activities.

GUIDELINES

The intent of this guide is to serve as a checklist for all fire management personnel.Be creative and seek new ways to implement MIST.

INCIDENT MANAGEMENT CONSIDERATIONS

Fire managers and firefighters select tactics that have minimal impact to values at risk. These values are identified in approved Land or Resource Management Plans. Standards and guidelines are then tied to implementation practices which result from approved Fire Management Plans.

- Firefighter and public safety cannot be compromised.
- Evaluate suppression tactics during planning and strategy sessions to ensure they meet agency administrator objectives and MIST. Include agency Resource Advisor and/or designated representative.
- Communicate MIST where applicable during briefings and implement during all phases of operations.
- Evaluate the feasibility of Wildland Fire Use in conjunction with MIST when appropriate for achieving resource benefits.

RESPONSIBILITIES

Agency Administrator or Designee

- Ensure agency personnel are provided with appropriate MIST training and informational/educational materials at all levels.
- Communicate land and fire management objectives to Incident Commander.
- Periodically monitor incident to ensure resource objectives are met.
- Participate in incident debriefing and assist in evaluation of performance related to MIST.

Incident Commander

- Communicate land and fire management objectives to general staff.
- Evaluate suppression tactics during planning and strategy sessions to see that they meet the Agency Administrator's objectives and MIST guidelines.
- Monitor operations to ensure MIST is implemented during line construction as well as other resource disturbing activities.
- Include agency Resource Advisor and/or local representative during planning, strategy, and debriefing sessions.

Resource Advisor

- Ensure interpretation and implementation of WFSA/WFIP and other oral or written line officer direction is adequately carried out.
- Participate in planning/strategy sessions and attend daily briefings to communicate resource concerns and management expectations.

- Review Incident Action Plans (IAP) and provide specific direction and guidelines as needed.
- Monitor on the ground applications of MIST.
- Provide assistance in updating WFSA/WFIP when necessary.
- Participate in debriefing and assist in evaluation of performance related to MIST.

Planning Section

- Use Resource Advisor to help assess that management tactics are commensurate with land/resource and incident objectives.
- Ensure that instructions and specifications for MIST are communicated clearly in the IAP.
- Anticipate fire behavior and ensure all instructions can be implemented safely.

Logistics Section

- Ensure actions performed around Incident Command Post (ICP), staging areas, camps, helibases, and helispots result in minimum impact on the environment.

Operations Section

- Evaluate MIST objectives to incorporate into daily operations and IAP.
- Monitor effectiveness of suppression tactics in minimizing impacts to resources and recommend necessary changes during planning/strategy sessions.
- Communicate MIST to Division Supervisors and Air Ops/Support during each operational period briefing. Explain expectations for instructions listed in Incident Action Plan.
- Participate in incident debriefing and assist in evaluation of performance related to MIST.

Division/Group Supervisor and Strike Team/Task Force Leader

- Communicate MIST objectives and tactics to single resource bosses.
- Recommend specific tasks on divisions to implement MIST.
- Monitor effectiveness of suppression tactics in minimizing impacts to resources and recommend necessary changes to Operations Section Chief.

Single Resource Bosses

- Communicate MIST objectives to crew members.
- Monitor work to ensure that crews are adhering to MIST guidelines and specific incident objectives.
- Provide feedback to supervisor on implementation of MIST.

IMPLEMENTATION

Keep this question in mind: What creates the greater impact, the fire suppression effort or the fire?

Safety

- Apply principles of LCES to all planned actions.
- Constantly review and apply the 18 Watch Out Situations and 10 Standard Fire Orders.
- Be particularly cautious with:
  - Burning snags allowed to burn.
  - Burning or partially burned live and dead trees.

- Unburned fuel between you and the fire.

Escape Routes and Safety Zones

- In any situation, the best escape routes and safety zones are those that already exist. Identifying natural openings, existing roads and trails and taking advantage of safe black will always be a preferred tactic compatible with MIST. If safety zones must be created, follow guidelines similar to those for helispot construction.
- Constructed escape routes and safety zones in heavier fuels will have a greater impact, be more time consuming, labor intensive and ultimately less safe.

General Considerations

- Consider the potential for introduction of noxious weeds and mitigate by removing weed seed from vehicles, personal gear, cargo nets, etc.
- Consider impacts to riparian areas when siting water handling operations.
  - Use longer draft hoses to place pumps out of sensitive riparian areas.
  - Plan travel routes for filling bladder bags to avoid sensitive riparian areas.
- Ensure adequate spill containment at fuel transfer sites and pump locations. Stage spill containment kits at the incident.

Fire Lining Phase

- Select tactics, tools, and equipment that least impact the environment.
- Give serious consideration to use of water or foam as a firelining tactic.
- Use alternative mechanized equipment such as excavators and rubber tired skidders rather than bulldozers when constructing mechanical line.
- Allow fire to burn to natural barriers and existing roads and trails.
- Monitor and patrol firelines to ensure continued effectiveness.

Ground Fuels

- Use cold-trail, wet line or combination when appropriate. If constructed fireline is necessary, use minimum width and depth to stop fire spread.
- Consider the use of fireline explosives (FLE) for line construction and snag falling to create more natural appearing firelines and stumps.
- Burn out and use low impact tools like swatters and gunny sacks.
- Minimize bucking to establish fireline: preferably move or roll downed material out of the intended constructed fireline area. If moving or rolling out is not possible, or the downed log/bole is already on fire, build line around it and let the material be consumed.

Aerial fuels–brush, trees, and snags*:*

- Adjacent to fireline: limb only enough to prevent additional fire spread.
- Inside fireline: remove or limb only those fuels which would have potential to spread fire outside the fireline.
- Cut brush or small trees necessary for fireline construction flush to the ground.
- Trees, burned trees, and snags:
  - Minimize cutting of trees, burned trees, and snags.

  - Do not cut live trees unless it is determined they will cause fire spread across the fireline or seriously endanger workers. Cut stumps flush with the ground.
  - Scrape around tree bases near fireline if hot and likely to cause fire spread.
  - Identify hazard trees with flagging, glowsticks, or a lookout.
- When using indirect attack:
  - Do not fall snags on the intended unburned side of the constructed fireline unless they are an obvious safety hazard to crews.
  - Fall only those snags on the intended burn-out side of the line that would reach the fireline should they burn and fall over.

Mopup Phase

- Consider using "hot-spot" detection devices along perimeter (aerial or hand-held).
- Use extensive cold-trailing to detect hot areas.
- Cold-trail charred logs near fireline: do minimal scraping or tool scarring. Restrict spading to hot areas near fireline.
- Minimize bucking of logs to check for hot spots or extinguish fire: preferably roll the logs and extinguish the fire.
- When ground is cool return logs to original position after checking.
- Refrain from piling: burned/partially burned fuels that were moved should be arranged in natural positions as much as possible.
- Consider allowing larger logs near the fireline to burn out instead of bucking into manageable lengths. Use a lever, etc. to move large logs.
- Use gravity socks in stream sources and/or combination of water blivets and fold-a-tanks to minimize impacts to streams.
- Personnel should avoid using rehabilitated firelines as travel corridors whenever possible because of potential soil compaction and possible detrimental impacts to rehab work.
- Avoid use of non-native materials for sediment traps in streams.
- Aerial fuels (brush, small trees, and limbs): remove or limb only those fuels which if ignited have potential to spread fire outside the fireline.
- Burning trees and snags:
  - *Be particularly cautious when working near snags (*ensure adequate safety measures are communicated).
  - The first consideration is to allow a burning tree/snag to burn itself out or down.
  - Identify hazard trees with flagging , glow-sticks or a lookout.
  - If there is a serious threat of spreading firebrands, extinguish with water or dirt.
  - Consider felling by blasting, if available.

Aviation Management

Minimize the impacts of air operations by incorporating MIST in conjunction with the standard aviation risk assessment process.

- Possible aviation related impacts include:
  - Damage to soils and vegetation resulting from heavy vehicle traffic, noxious weed transport, and/or extensive modification of landing sites.

  - Impacts to soil, fish and wildlife habitat, and water quality from hazardous material spills.
  - Chemical contamination from use of retardant and foam agents.
  - Biological contamination to water sources, e.g., whirling disease.
  - Safety and noise issues associated with operations in proximity to populated areas, livestock interests, urban interface, and incident camps and staging areas.
- Helispot Planning
  - When planning for helispots determine the primary function of each helispot, e.g., crew transport or logistical support.
  - Consider using long-line remote hook in lieu of constructing a helispot.
  - Consult Resource Advisors in the selection and construction of helispots during incident planning.
  - Estimate the amount and type of use a helispot will receive and adapt features as needed.
- Balance aircraft size and efficiency against the impacts of helispot construction.
- Use natural openings as much as possible. If tree felling is necessary, avoid high visitor use locations unless the modifications can be rehabilitated. Fall, buck, and limb only what is necessary to achieve a safe and practical operating space.

Retardant, Foam, and Water Bucket Use

- Assess risks to sensitive watersheds from chemical retardants and foam. Communicate specific drop zones to air attack and pilots, including areas to be avoided.
- Fire managers should weigh use of retardant with the probability of success by unsupported ground force. Retardant may be considered for sensitive areas when benefits will exceed the overall impact. This decision must take into account values at risk and consequences of expanded fire response and impact on the land.
- Consider biological and/or chemical contamination impacts when transporting water.
- Limited water sources expended during aerial suppression efforts should be replaced. Consult Resource Advisors prior to extended water use beyond initial attack.

Logistics, Camp Sites, and Personal Conduct

- Consider impacts on present and future visitors.
- Provide portable toilets at areas where crews are staged.
- Good campsites are found, not made. If existing campsites are not available, select campsites not likely to be observed by visitors
- Select impact-resistant sites such as rocky or sandy soil, or openings within heavy timber. Avoid camping in meadows and along streams or shores.
- When there is a small group try to disperse use. In the case of larger camps: concentrate, mitigate, and rehabilitate.
- Lay out camp components carefully from the start. Define cooking, sleeping, latrine, and water supplies.

- Prepare bedding and campfire sites with minimal disturbance to vegetation and ground.
- Personal Sanitation:
  - Designate a common area for personnel to wash up. Provide fresh water and biodegradable soap.
  - Do not introduce soap, shampoo or other chemicals into waterways.
  - Dispose of wastewater at least 200 feet from water sources.
  - Toilet sites should be located a minimum of 200 feet from water sources. Holes should be dug 6-8 inches deep.
  - If more than 1 crew is camped at a site strongly consider portable toilets and remove waste.
- Store food so that it is not accessible to wildlife, away from camp and in animal resistant containers.
- Do not let garbage and food scraps accumulate in camp.
- Monitor travel routes for damage and mitigate by:
  - Dispersing on alternate routes or
  - Concentrating travel on one route and rehabilitate at end of use.
- If a campfire is built, leave no trace of it and avoid using rock rings. Use dead and down wood for the fire and scatter any unused firewood. Do not burn plastics or metal.

Restoration and Rehabilitation

- Firelines:
  - After fire spread has stopped and lines are secured, fill in deep and wide firelines and cup trenches and obliterate any berms.
  - Use waterbars to prevent erosion, or use woody material to act as sediment dams.

Maximum Waterbar Spacing	
Percent Grade	Maximum Spacing, Feet
< 9	400
10 – 15	200
15 – 25	100
25 +	50

Table 1, Maximum Waterbar spacing.

  - Ensure stumps are cut flush with ground.
  - Camouflage cut stumps by flush-cutting, chopping, covering, or using FLE to create more natural appearing stumps.
  - Any trees or large size brush cut during fireline construction should be scattered to appear natural.
  - Discourage the use of newly created firelines and trails by blocking with brush, limbs, poles, and logs in a naturally appearing arrangement.
- Camps:
  - Restore campsite to natural conditions.

  - Scatter fireplace rocks and charcoal from fire, cover fire ring with soil, and blend area with natural cover.
  - Pack out all garbage.
- General:
  - Remove all signs of human activity.
  - Restore helicopter landing sites.
  - Fill in and cover latrine sites.
- Walk through adjacent undisturbed areas and take a look at your rehab efforts to determine your success at returning the area to as natural a state as possible.

APPENDIX E

Multi-year Fuels Plan (Timeline)

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
UF-9B Al Ayers -Contract Prep -Compliance **UF-9C West Ski Trail** -Cut/Haul -Pile Burn -Oversight **UF-9E Inholdings Phase 1** -Cut/Haul -Pile Burn -Compliance -Oversight **Entrance Road Phase 2** -Cut/Haul	**UF-9A East Ski Trail** -Compliance -Monitoring -Evaluation -Media support - Prep -Oversight -RX Burn **UF-9B Al Ayers** -RX Burn -Oversight -Media support - Monitoring **UF-9C West Ski Trail** -Contract Prep -RX Burn **UF-9E Inholdings Phase 2** -Cut/Haul -Pile Burn -Compliance **UF-7A** -Compliance -Prep **UF-7B** -Compliance **CG-1A** -Compliance -Prep	**UF-9E Inholdings** -RX Burn -monitor/eval **CG-1A** -RX Burn -monitor/eval **UF-7A** -RX Burn -monitor/eval **UF-7B** -Cut/Haul -Pile Burn **CG-5/8** -Compliance -Prep **HQ-41 HQ to Alcove** -Compliance -Prep **UF-9F** -Compliance -Prep **UF-9D** -Compliance -Prep **UF-14** -Compliance	**HQ-41 HQ to Alcove** -RX Burn -monitor/eval **CG-5/8** -RX Burn -monitor/eval **UF-9F** -RX Burn -monitor/eval **UF-14** -Contract Thinning -Pile Burn **CG-1B** -Compliance -Prep **HQ-44 Falls Trail** -Compliance -Prep	**UF-9D** -Rx Burn -monitor/eval **CG-1B** -RX Burn -monitor/eval **HQ-44 Falls Trail** -RX Burn -monitor/eval **UF-14A** -Prep **UF-14B** -Prep **CG-1C** -Compliance -Prep **UF-12** -Compliance	**CG-1C** -RX Burn -monitor/eval **UF-14A** -RX Burn -monitor/eval **UF-14B** -RX Burn -monitor/eval **UF-14C** -Prep **UF-12A** -Prep **UF-12B** -Prep **UF-27** -Compliance -Prep	**UF-14C** -RX Burn -monitor/eval **UF-27** -RX Burn -monitor/eval **UF-12A** -RX Burn -monitor/eval **UF-12B** -RX Burn -monitor/eval **UF-12C** -Prep **UF-12D** -Prep **LF-30** -Compliance -Prep	**UF-12C** -RX Burn -monitor/eval **UF-12D** -RX Burn -monitor/eval **LF-30** -RX Burn -monitor/eval **UF-12E** -Prep **UF-12F** -Prep **LF-28** -Compliance -Prep **LF-29** -Compliance -Prep	**UF-12E** -RX Burn -monitor/eval **UF-12F** -Rx Burn -monitor/eval **LF-28** -RX Burn -monitor/eval **LF-29** -RX Burn -monitor/eval **HQ-45A** -Compliance -Prep **LF-38** -Compliance -Prep	**LF-38** -RX Burn -monitor/eval **HQ-45A** -RX Burn -monitor/eval **HQ-45B** -Compliance -Prep **HQ-45C** -Compliance - Prep **UF-7B** -Prep **UF-7C** -Compliance -Prep

Refer to Figure 2.2 and 2.3 for location of projects.

UF= Upper Frijoles
CG=Cerro Grande
HQ=Headquarters
LF=Lower Frijoles

APPENDIX F

HISTORICAL LANDUSE AND VEGETATION RESOURCE IMPACTS

The vegetation resources within Bandelier National Monument have been profoundly affected by historic land use practices common throughout much of the western United States. Essentially all of the vegetation types in the park have been altered, to some degree, by the effects of historic grazing and active suppression of wildfires (Allen, 1989). Some communities have undergone relatively minor structural changes which can be reversed through iterative mechanical and fire treatments, while others have experienced more permanent changes in both species composition and functionality.

Fire suppression precipitated fundamental changes in plant community structure and composition: it indirectly provided the continuous ladder and crown fuels necessary to support large scale crown fire in ponderosa forests, supported increased densities of trees in pinyon-juniper woodlands which has precipitated accelerated erosion, and allowed progressive encroachment of woody plants in former meadow and grassland systems.

Around 1880, historic land use activities (i.e. logging, fuel-wooding, grazing, hunting, and fire suppression) intensified and began to noticeably affect plant communities. Ponderosa and mixed coniferous forests were timbered, fence posts and fuel wood were extracted from accessible woodlands, fires were suppressed, and the entire landscape was intensively grazed by domestic livestock. Beginning around 1916, many of these consumptive activities ceased, although cattle grazing continued through 1940 and a population of feral burros was present until the mid-1980’s. During the last five hundred years, local plant communities have been shaped by intermittent human land-use; extant plant communities at Bandelier are a product of this history of human use and disturbance, and disruption or alteration of communities and processes.

Increases in woody plant density across the landscape is the major legacy of historic grazing and fire suppression activities. More recently, the alteration of water regimes along the Rio Grande corridor resulting from irrigation, flood and sediment control activities has affected riparian habitat. Beginning in the early 1980's, park lands below 5460 feet (1664 meters) in White Rock Canyon along the Rio Grande have been seasonally inundated by Cochiti Reservoir in the context of flood and sediment control by the operation of Cochiti Dam. Extended periods of inundation during the mid-1980's killed all living vegetation within the flood zone and deposited many feet of silt. Native soils and natural habitats were altered; cottonwood bosques, springs and seeps and other riparian settings were displaced with sterile mudflats and subsequent dense growth of agricultural weeds.

APPENDIX G
LIST OF SELECTED WILDLIFE SPECIES BY VEGETATION COMMUNITY THAT ARE PRESENT IN BANDELIER

	Vegetation Community							
	Montane Grasslands	**Aspen Groves**	**Mixed Conifer**	**Ponderosa Pine**	**Pinyon-Juniper**	**Juniper-Shrub Grasslands**	**Canyon Slope Complex**	**Canyon Bottom Complex**
Birds								
Acorn woodpecker		Y	Y	Y	Y	Y		Y
American kestrel	Y	Y	Y	Y	Y	Y	Y	Y
American robin	Y	Y	Y	Y	Y		Y	Y
American three-toed woodpecker		Y	Y	Y	Y		Y	Y
Ash-throated flycatcher				Y	Y	Y	Y	Y
Band-tailed pigeon		Y	Y	Y	Y	Y	Y	Y
Bewick's wren		Y	Y	Y	Y	Y	Y	Y
Black swift	Y	Y	Y	Y	Y		Y	Y
Black-capped chickadee	Y	Y	Y	Y	Y			Y
Black-chinned hummingbird		Y		Y	Y	Y		Y
Black-headed grosbeak		Y	Y	Y	Y	Y		Y
Black-throated grey warbler				Y	Y	Y		Y
Blue-grey gnatcatcher					Y	Y	Y	Y
Brewer's sparrow					Y	Y	Y	Y
Broad-tailed hummingbird	Y	Y	Y	Y	Y		Y	Y
Brown creeper		Y	Y	Y	Y		Y	Y
Bushtit		Y	Y	Y	Y	Y	Y	Y
Canyon wren				Y	Y	Y	Y	Y
Cassin's kingbird				Y	Y	Y	Y	Y
Chipping sparrow	Y	Y	Y	Y	Y	Y	Y	Y
Common raven	Y	Y	Y	Y	Y	Y	Y	Y
Cooper's hawk	Y	Y	Y	Y	Y	Y	Y	Y
Cordilleran flycatcher		Y	Y	Y	Y	Y	Y	Y
Dark-eyed junco	Y	Y	Y	Y	Y	Y	Y	Y
Downy woodpecker		Y	Y	Y	Y			Y
Dusky flycatcher		Y	Y	Y	Y	Y	Y	Y
Flammulated Owl		Y	Y	Y	Y	Y	Y	Y
Grace's warbler			Y	Y				Y

Great horned owl	Y	Y	Y	Y	Y	Y	Y	Y
Green-tailed towhee	Y	Y	Y	Y	Y	Y	Y	Y
Hairy woodpecker		Y	Y	Y	Y		Y	Y
Hammond's flycatcher		Y	Y	Y	Y	Y	Y	Y
Hepatic tanager			Y	Y	Y	Y	Y	Y
Hermit thrush		Y	Y	Y	Y		Y	Y
House finch			Y	Y	Y	Y	Y	Y
House wren	Y	Y	Y	Y	Y	Y	Y	Y
Juniper titmouse				Y	Y	Y	Y	Y
Lesser goldfinch				Y	Y	Y	Y	Y
Lewis's woodpecker			Y	Y	Y		Y	Y
Mexican spotted owl		Y	Y	Y				
Mountain bluebird	Y	Y	Y	Y	Y	Y	Y	Y
Mountain chickadee	Y	Y	Y	Y	Y	Y	Y	Y
Northern flicker	Y	Y	Y	Y	Y	Y	Y	Y
Northern goshawk	Y	Y	Y	Y	Y			
Peregrine Falcon		Y	Y	Y	Y	Y	Y	
Pinyon jay				Y	Y	Y	Y	
Plumbeous vireo (Solitary)		Y	Y	Y	Y	Y	Y	Y
Pygmy nuthatch		Y	Y	Y				
Red-naped sapsucker		Y	Y	Y	Y		Y	Y
Say's phoebe				Y	Y	Y	Y	Y
Stellar's jay		Y	Y	Y	Y	Y	Y	
Violet-green swallow	Y	Y	Y	Y	Y	Y	Y	Y
Virginia'a warbler		Y	Y	Y	Y	Y	Y	Y
Warbling vireo		Y	Y	Y	Y	Y	Y	Y
Western bluebird		Y	Y	Y	Y	Y	Y	Y
Western scrub-jay			Y	Y	Y	Y	Y	Y
Western tanager		Y	Y	Y	Y	Y	Y	Y
Western wood-peewee			Y	Y	Y	Y	Y	Y
White-breasted Nuthatch		Y	Y	Y	Y	Y	Y	Y
White-throated swift	Y	Y	Y	Y	Y	Y	Y	Y
Williamson's sapsucker		Y	Y	Y	Y	Y	Y	Y
Yellow-rumped warbler	Y	Y	Y	Y	Y	Y	Y	Y
Mammals								
Abert's squirrel			Y	Y	Y	Y		
American marten	Y	Y	Y	Y				
Audubon's desert cottontail					Y	Y	Y	Y
Badger	Y	Y	Y	Y	Y	Y	Y	Y
Big brown bat			Y	Y	Y			
Black bear		Y	Y	Y	Y	Y	Y	Y

Black-tailed jackrabbit			Y	Y	Y	Y	Y	
Bobcat	Y		Y	Y	Y	Y	Y	Y
Botta's pocket gopher	Y		Y	Y	Y	Y	Y	
Brazilian (Mexican) free-tailed bat			Y	Y	Y	Y	Y	
Brush mouse	Y	Y	Y	Y	Y	Y	Y	Y
Colorado chipmunk		Y	Y	Y	Y	Y	Y	
Coyote	Y	Y	Y	Y	Y	Y	Y	Y
Deer mouse	Y	Y	Y	Y	Y	Y	Y	Y
Elk	Y	Y	Y	Y	Y	Y	Y	
Fringed myotis			Y	Y	Y	Y	Y	
Golden-mantled ground squirrel	Y	Y	Y	Y	Y	Y	Y	
Gray fox			Y	Y	Y	Y	Y	Y
Hoary bat				Y	Y	Y		
Long-eared myotis			Y	Y	Y	Y		
Montane vole	Y	Y	Y	Y	Y			
Mule deer	Y	Y	Y	Y	Y	Y	Y	Y
Nothern pocket gopher	Y	Y	Y	Y				
Pallid bat				Y	Y	Y	Y	
Pinyon mouse					Y	Y	Y	
Porcupine	Y	Y	Y	Y	Y	Y	Y	Y
Raccoon	Y	Y	Y	Y	Y	Y	Y	Y
Red squirrel			Y	Y				
Ringtail			Y	Y	Y	Y	Y	
Rock squirrel			Y	Y	Y	Y	Y	
Silky pocket mouse					Y	Y	Y	
Silver-haired bat		Y	Y	Y	Y	Y	Y	
Striped skunk	Y	Y	Y	Y	Y	Y	Y	Y
White-throated woodrat					Y	Y	Y	Y
Yuma myotis					Y	Y	Y	Y
Amphibians								
Jemez Mountains salamander		Y	Y	Y				
Tiger salamander	Y	Y	Y	Y				Y
Red spotted toad			Y	Y	Y	Y	Y	Y
Woodhouse's toad					Y	Y	Y	
Canyon treefrog					Y	Y	Y	Y
Striped chorus frog		Y	Y	Y	Y	Y	Y	
Reptiles								
Checkered whiptail					Y	Y	Y	
Chihuahua whiptail			Y	Y	Y	Y	Y	
Collared lizard			Y	Y	Y	Y	Y	

Eastern fence lizard				Y	Y	Y	Y	
Gopher (bull) snake			Y	Y	Y	Y	Y	
Many-lined skink		Y	Y	Y	Y	Y	Y	
Plateau whiptail				Y	Y	Y	Y	
Ringneck snake			Y	Y	Y	Y	Y	
Striped whipsnake			Y	Y	Y	Y	Y	
Tree lizard			Y	Y	Y	Y	Y	
Western diamondback rattlesnake			Y	Y	Y	Y	Y	
Western terrestrial garter snake	Y	Y	Y	Y	Y	Y	Y	Y

Source: Brown 1994, Cook et al. 2000,
Fettig et al. 2003, NPS 1992, 1999

APPENDIX H
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